Research Policy 50 (2021) 104132

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Organisational institutionalisation of responsible innovation

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ARTICLE INFO

Keywords:
Responsible Innovation
Organisational institutionalism
Practice
Policy

ABSTRACT

We describe the institutionalisation of responsible innovation (RI) over the last decade at the Engineering and Physical Sciences Research Council (EPSRC) and universities funded by it as a focal point for RI in the UK. Drawing on organisational theory we identify factors influencing the dynamics of RI institutionalisation, including forces of legitimation, entrepreneurship and decoupling. We report significant institutionalisation at the EPSRC prior to 2013, when it published its RI policy. Notwithstanding instances of experimentation and assimilation since, we report limited institutionalisation within research communities in universities as RI has encountered competing institutional logics, responsibility norms and epistemic practices. Our findings suggest an ongoing and dynamic process of translation that reflects RI's status as a performative and contested discourse 'in the making'.

1. Introduction

Responsible Innovation (RI) and Responsible Research and Innovation (RRI) are two significant, policy - relevant discourses relating to science, technology, innovation and society that have emerged in parallel over the last decade (Owen and Pansera, 2019; Ribeiro et al., 2017; Rip, 2014). RRI emerged from the European Commission (EC) as a policy-driven discourse at the turn of the last decade (Owen et al., 2012). With an overall aim to align research and innovation to the values, needs and expectations of society and with a strong emphasis on addressing 'societal grand challenges' (Kuhlmann and Rip, 2014; Lund Declaration, 2009; Rome Declaration, 2014), its early formulation shared much in common with the discourse of RI (von Schomberg, 2012). The discourse of RI also emerged at the turn of the last decade. While it overlaps in some areas with the EC RRI discourse it should be seen as being distinct from it, given the focus of the latter on gender, science education, open access, research ethics and engagement. RI has historical foundations in the social sciences, and science and technology studies (STS) in particular, that go back many decades (Rip, 2014), including such concepts as anticipatory governance, participatory action research and constructive and real time technology assessment (Barben et al., 2008; Guston and Sarewitz, 2002; Schot and Rip, 1996). Foundational texts articulating a framing of and rationale for RI build on these cognates (Owen et al., 2013; Stilgoe et al., 2013). They stress innovation as a complex, future-creating phenomenon with the potential to co-produce risks and ethical, social, environmental and political entanglements in uncertain and unpredictable ways. Rooted in a constructivist ontology and with a strong emphasis on future-oriented responsibility (Adam and Groves, 2011; Pellizzoni, 2004; Richardson, 1999) they seek to open up, understand and shape innovations as 'futures in the making' (Stirling, 2008). In order to do so they advocate the integration and embedding within innovation (and knowledge production aimed at this) of capacities for anticipation, inclusive deliberation and dialogue (with publics and stakeholders), reflexivity (first and second order) and responsiveness (shaping innovation agendas and trajectories). The RI discourse stresses an epistemology that is both inter and transdisciplinary, characterised by broadly - configured values inputs, knowledge co-production and adaptive learning.

The UK Engineering and Physical Research Council has been an important location for the emergence of the RI discourse in the UK and beyond over the last decade (Owen, 2014; Owen and Goldberg, 2010). As we describe below, academics - including two of the current authors - worked closely with the EPSRC to develop a framework for RI (Stilgoe et al, 2013) which was subsequently adopted by the Council and incorporated into policy in 2013 (EPSRC, 2013a; Owen, 2014). The current paper is the first major follow up to that original study. This latter period has witnessed a shift in policy emphasis at the EPSRC towards embedding RI into organisational practice, with the ambition for this to become 'business as usual' for both itself and the research communities in universities that it funds (EPSRC, 2019). This has mirrored a policy

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https://doi.org/10.1016/j.respol.2020.104132
Received 18 February 2020; Received in revised form 17 September 2020; Accepted 21 September 2020
Available online 1 October 2020

ambition by the EC over the last five years to 'mainstream' RRI across Europe (Novitzky et al., 2020; Rome Declaration, 2014).

The discourse of RI extends debates about the relationships between science, technology, innovation and society and the responsibilities of scientists, innovators, markets and the state that go back many decades (Bernal, 1939; Douglas, 2003; Polanyi, 1962; Rip, 2014; Pfotenhauer and Juhl, 2017). It also implies significant changes to these relationships and responsibilities. This includes approaches to producing new knowledge and teaching (e.g. within scientific curricula in higher education). These, in turn, imply significant changes to organisational logics, norms and practices within research funding and research performing organisations. But while there have been informative studies of micro practices of RI (e.g. Glerup et al. (2017), see also Schuijff and Dijkstra (2020) for a recent review) there has been surprisingly little engagement between scholars of RI and that considerable body of scholarship relating to institutionalisation and the dynamics of organisational change (Genus and Iskandarova, 2018; Randles, 2017). Furthering this exchange is important in terms of providing a theoretically-informed analysis of the dynamics and extent of RI translation within organisations to date (Doezsma et al., 2019; Wedlin and Sahlin, 2017). This can provide insights to support policy aimed more broadly at fostering organisational institutionalisation of RI. These then formed the two aims of our study. While we did not aim to develop insights for organisational or STS theory *per se*, our study highlights the potential for a future research agenda at the interface of STS and organisational institutionalism which we briefly discuss before closing.

Our study focuses on RI, which we treat as an umbrella term (Rip and Voß, 2013) and performative discourse (Smets et al., 2017). We also consider RI as a social object seeking to gain legitimation (Johnson et al., 2006), as an innovation (Rip, 2014) and as an emerging field (Maguire et al., 2004) with the potential to disrupt existing institutional logics relating to research and innovation (Ocasio et al., 2017; Thornton and Ocasio, 2008). Finally, we recognise RI as being a contested discourse (de Hoop et al., 2016; Kuntz, 2017; Mertens, 2018; van Oudheusden, 2014; Zwart et al., 2014), for example in corporate settings where much innovation occurs (Lemmens, 2015; Brand and Blok, 2019) or in situated contexts such as innovation in the so called 'global south' (Doezsma et al., 2019).

We base our analysis on both qualitative and quantitative data covering a period of ten years (2008 - 2018) over which we as authors have had access and engagement with the EPSRC. Our unit of analysis is the EPSRC and research communities funded by it - principally in universities – which have been a focal point for RI translation in the UK. The EPSRC is the UK's largest public funder of research in the engineering and physical sciences. Research councils such as the EPSRC play an important and influential role in national research and innovation systems as key intermediaries between government, universities and, increasingly, third party organisations that include industrial partners (Braun, 1993). EPSRC funds research and training aimed at discovery and the production of fundamental knowledge (mode 1) as well as more strategic research (mode 2) aimed at fostering innovation, economic impact and social prosperity (EPSRC, 2019; Nowotny et al., 2003).

The remainder of the paper is set out as follows: in the following section we provide a theoretical underpinning for our analysis, drawing on the literature relating to organisational institutionalism. We then describe our research design and the case study in detail, critically discussing our findings and relating this to theory, before closing with recommendations for research and innovation policy.

2. Theoretical background

2.1. The context for RI institutionalisation

RI has not emerged in a vacuum. It has important antecedents in the UK, the context for our study. Of these, a history of public engagement with science and emerging technologies is notable (Sykes and Macnaghten, 2013). In the wake of a number of high-profile science and technology crises in the 1990s and 2000s — including the 'mad cow' (BSE) crisis and highly politicized controversies over GM foods and crops — there was growing awareness of the limits of technocratic risk assessment and attempts to build trust in science and scientific institutions by 'educating' the public, using 'deficit' and 'public understanding of science' modes of engagement. One response, developed first in academia (Irwin, 1995; Jasanoff, 2003, 1997; Wynne, 2001, 1992) and subsequently in science policy (Wilsdon and Willis, 2004; House of Lords, 2000; RCEP, 1998;) was to embed more 'upstream', deliberative societal engagement in the governance of techno-science. Aimed generally at improving relations between science and society, the motivations for this response were and continue to be substantive, normative and instrumental (Stirling, 2008). They have included the belief that it might help restore legitimacy and public trust in science, avoid future controversy, democratise research, lead to socially robust research and innovation policy and outcomes, and render scientific culture and praxis more socially accountable and reflexive (Irwin, 2006, 2001; Macnaghten, 2020, 2010). 'Catalysts', 'Beacons' and a National Centre for public engagement were created in UK universities. Initiatives were also created within the machinery of government, including the Sciencewise dialogues on science and technology (Macnaghten and Chilvers, 2014; Sciencewise, 2020). Scholars have in turn learned from decades of practice, developing more critical and reflexive approaches to engagement processes which serve as important foundations for RI (Chilvers, 2013; Chilvers and Kearnes, 2016, 2020; De Saille, 2015; Doubleday and Wynne, 2011; Smallman, 2016; Stilgoe et al., 2014).

It is also important to note that research councils and universities, the specific context for RI institutionalisation in our study, present with a number of co-existing institutional logics (Thornton and Ocasio, 2008; Ocasio et al, 2017) with which the discourse of RI intersects. In universities these include the logic of the autonomous 'ivory tower' rooted in independent research, critique and debate (Polanyi, 1962). This increasingly vies with a 'utilitarian' logic associated with strategic research and such concepts as the entrepreneurial (and occasionally civic) university, a logic which is particularly engrained in research intensive universities (Shields and Watermeyer, 2018). Finally, a 'managerial' logic, aligned with new public management practices (Docherty, 2016), reflects universities as increasingly bureaucratic, centralised and competitive organisations (Martin, 2016; McCann et al., 2020). Such logics heavily influence and configure behaviours and practices, which over time become embedded, routinised and repetitive, in turn maintaining institutions[1] associated with them (Lawrence and Suddaby, 2006).

These include responsibilities that relate specifically to research and innovation, some of which are codified and enforced formally, some of which relate to more informal, cultural aspects and many of which are legitimated by external expectations and drivers (Glerup et al., 2017). Randles (2017, p.20) describes these 'de facto' responsibilities as 'what actors already do… in order to embed institutionalised interpretations of what it means to be responsible into the practices, processes, organisational structures and outcomes of research and innovation'. Examples include norms and practices within particular academic disciplines (e.g. relating to publishing), those relating to academic partnerships and commercialisation (Perkmann et al., 2013) and responsibilities encoded in policies relating to research integrity, academic conduct and research ethics. These latter responsibilities are well established and arguably sufficient for 'mode 1' type, 'fundamental' research, where there are few expectations or imaginaries of economic and social impact (at least initially). However, research councils in the UK and beyond increasingly fund 'mode 2' type research in universities that is more strategic in

[1] We adopt Scott's definition of institutions as being the 'cognitive, normative and regulative structures and activities that provide stability and meaning to social behaviour' (Scott, 1995, p.33).

nature (D'Este and Patel, 2007), including that which is intentionally aimed at innovation, often within a triple helix model of government-university-business interactions (Etzkowitz and Leydesdorff 2000; Etzkowitz and Zhou, 2019). There is a growing policy agenda in the UK and other countries for universities (and research councils) to demonstrate impact from publicly – funded research, aimed at increasing public accountability and contributing to innovation, skills development, the knowledge economy and the addressing of societal challenges (Ashworth et al., 2019; Glerup et al., 2017; Hill, 2016). In combination these create additional expectations and behaviours for which current responsibility norms associated with mode 1 type research remain important but are arguably insufficient. This is an insufficiency RI aims to address through forms of organisational change, challenging current interpretations of what it means to be responsible.

2.2. RI and the dynamics of organisational change

We can draw on insights from organisational theory to identify factors likely to influence RI institutionalisation. Organisational institutionalism is a useful lens as it emphasises the interconnectedness of individuals, organisations and the supra-organisational context (Greenwood et al., 2017). It stresses the relationality between an organisation and its external environment (the norms, institutions and politics of wider society) as sources of endorsement, authorisation and legitimation for logics, behaviours and practices within organisations (Greenwood et al., 2017; Meyer and Rowan 1977; Scott, 1995). It draws particular attention to concepts of legitimacy and legitimation (Deephouse et al., 2017; Deephouse and Suchman, 2008; Johnson et al., 2006; Oliver, 1991; Suchman, 1995) and their significance for maintaining the stability of existing institutions and the formation of new ones (DiMaggio and Powell, 1983; Huy et al., 2014; Maguire et al., 2004; Oliver, 1992; Smets et al., 2017; Tost, 2011).

Disruption, instability or crisis, emerging either in the external context or from within the organisation itself, can create legitimacy challenges to which organisations may choose, or be forced, to respond (Dacin and Dacin, 2008). Global pandemics and financial crises (Owen, 2020), scientific crises (see above), disruptive innovation (Kammerlander et al., 2018) and substantive changes in the external policy or regulatory environment (Dacin and Dacin, 2008) are just a few examples. Such legitimacy challenges can relate to perceived or actual failure in the performance or utility of an existing institution or practice, or their purposes and the values that underpin them (Oliver, 1992). During such moments, incumbent logics, institutions or practices can come under scrutiny, depending on the nature of the challenge and the dynamics between the organisation and its internal and external stakeholders (Deephouse et al., 2017; Deephouse and Suchman, 2008; Kern et al, 2018). This can create internal dissonance and even conflict, serving to 'fragment shared interpretations of appropriate organizational behaviour' (Oliver, 1992, p. 568). This may result in the reframing, dissipation or even rejection of an incumbent norm or practice, thereby initiating its de-institutionalisation (Dacin and Dacin, 2008), 'the process by which the legitimacy of an established or institutionalised organisational practice erodes' (Oliver, 1992, p. 564). In total legitimacy challenges can jolt organisations out of a tendency towards incrementalism, iso-morphism, mimesis and conformity (Boxenbaum and Jonsson, 2008; DiMaggio and Powell, 1983; Greenwood et al., 2002; Kitagawa et al., 2016; Meyer et al., 1990). They can create critical juncture moments for organisations, foregrounding organisational shortcomings and relaxing constraints on agency, in turn inviting local innovation (e.g. relating to RI) as an important element of 'theorisation' that is key to new practice creation and institutionalisation (Greenwood et al, 2002).

It is important to note that institutionalisation does not necessarily require dramatic crises. It can also arise from the accumulation of endogenous, gradual and incremental 'creeping changes' (Docherty, 2016; Streeck and Thelan, 2005) and be a generative product of the mundane ''doing'' of everyday work. Likewise, legitimacy challenges in themselves do not straightforwardly lead to change (Dacin et al, 2002). This will depend on the dynamics between RI and those situated, de facto norms, logics and practices with which it intersects, the net impact of which will determine the extent and nature of RI translation (Oliver, 1992; Streeck and Thelan, 2005; Dacin and Dacin, 2008; Randles, 2017). How incumbents respond to the new discourse is key. This can be substantive or symbolic (Bercovitz and Feldman, 2008; Bromley and Powell, 2017). They may engage substantively, or alternatively deflect (Smith-Doerr, 2006) or buttress their positions, displaying sometimes exceedingly stubborn resistance (Lounsbury and Crumley, 2007; Oliver, 1991). This will in part reflect their values and social learning experiences, relating for example to their academic and professional training (Bercovtiz and Feldmann, 2008). It will also reflect the nature of the regulative, normative and cultural-cognitive institutions that configure their organisation, discipline and field (Scott, 2017, 1995). Such regulative institutions can include formal reward and incentive regimes, themselves reinforced by regulative policies emanating from higher authorities upon which an organisation depends for resources or legitimacy (DiMaggio and Powell, 1983; Oliver, 1991) e.g. periodic national research assessments linked to funding settlements in universities (Hicks, 2012). These can serve to authorise, legitimate and maintain existing logics and behaviours within organisations such as universities whilst sanctioning against new ones (Lawrence and Suddaby, 2006).

In this dynamic environment, in order to build and sustain an alternative vision and narrative - in our case for RI - the literature identifies a critical need for effective and enterprising institutional entrepreneurship by those who have sufficient interest and *agency* to overcome structure, test new behaviours, and encourage other actors to behave correspondingly (Dacin et al., 2002; DiMaggio, 1988; Fligstein, 1997; Greenwood et al., 2002; Hardy and Maguire, 2017, 2008; Maguire et al., 2004; Smets et al., 2017; Streeck and Thelan, 2005). Using persuasive argumentation and political negotiation these individuals can compellingly challenge the status quo and offer solutions to organisational problems, presenting an alternative future (Maguire et al, 2004). As advocates they can articulate a case for change and mobilise stakeholders and resources within and beyond the organisation through bridging and boundary spanning activities (Hardy and Maguire, 2008) and other forms of 'institutional work' (Lawrence and Suddaby, 2006; Lawrence et al., 2013). Such entrepreneurs are 'adept at critical reflection taken as a capability to imagine oneself as if outside of the structures which bind, and critically look back into those structures' (Randles, 2017, p.17).

The literature also identifies the need for effective and inspirational leadership (Bercovitz and Feldman, 2008; Kraatz and Block, 2008) and an organisational culture that enables and encourages absorptive capacity, experimentation, risk taking and collaboration. These make space for negotiation and the building of advocacy coalitions for the new discourse, which evolves 'from ad-hoc localised experiments to extensively – shared, routinized techniques, norms, standards and governance' (Randles, 2017, p.36). This, Randles argues, necessarily has an overflowing character, reaching relevant constituencies and stakeholders both within and external to an organisation (in the case of EPSRC the academic communities it funds).

In the remainder of the paper we seek to build on these insights from organisational institutionalism to understand and interrogate RI translation within our case study. In doing so we aim to disclose the dynamics of institutionalisation that have been at play and factors that may have influenced this to date, including forces of legitimation, institutional entrepreneurship and incumbency. We draw on this analysis to assess the extent and nature of RI translation in our case study to date, in turn allowing us to develop insights for policy.

3. Research design and methods

We adopted a mixed methods research design incorporating both

qualitative and quantitative elements (see Table 1). For the qualitative analysis we combined document review (public and EPSRC internally - restricted) with an analysis of transcribed, semi - structured interviews, recordings made at a one-day stakeholder workshop held at EPSRC and notes made at two subsequent internal focus group meetings at the Research Council. Adopting an approach based on Gioia et al. (2012), our analysis followed the following stages: first we coded our data using Nvivo9, maintaining the integrity of 1st-order (informant-centric) terms. As suggested by Miles and Huberman (2003), we performed this using a set of a priori constructs as a topic guide: *how RI is framed in the organisation, history of RI evolution, values and motivations to pursue RI, perceived barriers and incentives* and *RI - related practices*. After this first step, we performed a 2nd-order analysis in which we induced concepts suggested by our 1st-order codes, these being finally assembled into a small number of overarching aggregate dimensions, each of which we discuss in turn below.

We supplemented our interviews and document analysis with analysis of three additional datasets. To understand how RI has been positioned within funding calls made by EPSRC over time and the response of the EPSRC-facing academic community to these calls we analysed all publicly – available call documents published by EPSRC between 2013 (when its RI policy was first published, see below) and 2017, enabled by a search of the keywords 'Responsible Innovation', 'Responsible Research and Innovation' and the 'AREA framework' (details below)[2]. We complemented this with a search of EPSRC's internal databases for all proposals submitted to the Council between April 2009 and February 2017, again using the keywords above.

Additionally, in 2013 the EPSRC funded 115 Centres for Doctoral Training (its PhD training programme across the UK) which included an encouragement for RI training (EPSRC, 2013b). To understand the nature of implementation of RI in these PhD training programmes (which are hosted by universities across the UK across a range of themes), we analysed the responses from a midterm review conducted by EPSRC of its CDTs in December 2016. As part of this review each CDT was required to answer the following question: 'What have you been doing to help your students to explore, discuss and reflect on the wider ethical issues around their work (e.g. Responsible Innovation training)?' A word limit of 100 words was provided for each response. Responses from all CDTs, which were anonymised by EPSRC before being provided to us, were categorised and a content analysis performed.

4. Research findings

4.1. Initial institutionalisation of RI at the EPSRC

Although it has important antecedents in the UK (see Section 2.1 above), RI as a term at the EPSRC (and in the UK more broadly) can be specifically traced to an initial pilot study conducted within the Council in 2009. This, for the first time, required grant applicants to a call for proposals in nanoscience to reflect on the broader social, health and environmental risks of their research and its envisaged applications (Owen and Goldberg, 2010). This pilot laid the ground at EPSRC for an approach to RI that would evolve significantly over the period between 2009 and 2012, from an initial framing around risk to a far broader one framed around the so-called 'AREA framework' (see below). Interactions between a small number of academics (including two of the current authors) and a number of staff at the EPSRC - formally through its advisory 'Special Interests Group'[3] and more informally through interaction and collaboration - as well as the findings and recommendations from two public dialogues (one on nanoscience (Jones, 2008) and another on synthetic biology (BBRSC, 2010)) were pivotal in fostering RI's initial assimilation within the Council. This culminated in the then EPSRC CEO formally adopting the term 'responsible innovation' and committing the Council to developing a framework for RI (Delpy, 2011), a project which began in 2011.

4.2. Policy development

The period between 2011 and 2012 was an active phase of RI institutionalisation at the EPSRC, coinciding with the rise of the RRI discourse within the EC (Owen et al, 2012). During this period academics working on the EPSRC framework project developed a conceptual framing for RI (Stilgoe et al, 2013). They and a small number of others also acted as boundary spanners between the UK RI and EC RRI discourses. At the invitation of the EPSRC, the emerging thinking within the RI framework project was employed to inform and support decisions made during 2011 concerning a project ('SPICE') focussed on planetary climate engineering (Macnaghten and Owen, 2011). This proved to be an important location to support both the formulation and refinement of the framework for RI and its initial demonstration within a contentious area of science and engineering. It served to locate what might otherwise have been an abstract, conceptual framework into the real world of EPSRC's business. In doing so it engaged and mobilised a number of internal stakeholders in the Council itself, from the level of portfolio manager to Directors and the EPSRC Executive Team.

Parallel activities in two key themes were also significant for RI institutionalisation during this period. In the ICT theme in 2011, the EPSRC funded a project that had originally been focussed on ethical issues in ICT, but which now became framed around the broader discourse of RI. The ICT theme, along with synthetic biology, would subsequently become a key location for RI institutionalisation. Building on the earlier public dialogue, during 2012 a national roadmap for synthetic biology was published that included a significant pillar on RI (Marris and Calvert, 2019), and calls for proposals in this area by EPSRC also began to include reference to RI, with a small number of research grants funded in 2013 that included a RI element.

During this period key individuals within the Strategy unit at the EPSRC, liaising with this small group of academics and the Council's Special Interests Group were critical in making the internal case for RI. A year later in the Autumn of 2013 this led to the publication of a formal RI policy (EPSRC, 2013a), adopting the RI framework developed by Stilgoe et al (2013). This was presented under an 'AREA' acronym (anticipate, reflect, engage, act). In parallel, the EPSRC set out expectations for itself and those in receipt of EPSRC funding. The Council saw its own role as promoting RI, providing training, fostering understanding and interdisciplinary interactions and welcoming funding requests that embed RI elements. It pledged to ensure RI was prominent in its strategic thinking, including proposal assessment. In terms of researchers and research organisations, the Council advocated a flexible approach that reflects the different types of research (mode 1, mode 2) that it funds. Notwithstanding this, EPSRC expected all researchers to anticipate, reflect and engage on the wider dimensions of their research and that organisations should encourage and support researchers to develop RI as a core capability. The 'how' of operationalising RI in universities was not prescribed by the Council, or indeed by those who published the RI framework (Stilgoe et al, 2013): this was left for universities and researchers to define and implement locally as appropriate to the context and nature of the research itself.

4.3. RI institutionalisation 2013–2017

The emphasis for EPSRC following publication of its 2013 policy was to embed and mainstream RI in practice both within the Council itself and in research communities funded by it, with an ambition to make RI 'business as usual'. The Council shortly thereafter made a small number of strategic investments aimed at capacity building. In addition to internal workshops and presentations (e.g. to portfolio managers) aimed

[2] Available at: www.epsrc.ac.uk/files/funding/calls/ - accessed Jan 31st, 2020.

[3] Known prior to 2012 as the 'Societal Issues Panel'

Table 1
Data sources.

Methods	Data collected	Concepts analysed
Semi-structured interviews with EPRSC staff who had experience of/ encountered RI or for whom RI fell within their organisational role	11 interviews	RI history in EPSRC and national context Framing and implementation of RI
Semi-structured interviews with UK academics with direct experience of RI	13 interviews	EPSRC – facing academic community engagement with RI
Document analysis	Internal restricted and publicly available documents	National context; organisational policies, strategy, communications
Analysis of funding calls I (2013-2017)	Keyword enabled search of 299 call documents for RI content	Translation of RI into practice and community response
Analysis of funding calls II (2009-2017)	Keyword enabled search of all proposals submitted to EPSRC between 2009 and 2017	Translation of RI policy into practice and community response
Analysis of RI in Centres for Doctoral Training Scheme (PhD)	Responses to RI question in 2016 CDT midterm review	Translation of RI policy into practice and community response.
Focus groups with EPSRC staff (December 2017 and April 2018)	Discussion of findings with EPSRC staff	Translation of RI policy into practice
National Stakeholder workshop (March 2017)	Deliberative forum involving 14 stakeholders (academics and staff from Research Councils and Innovate UK)	National context, translation of RI into practice

at raising awareness with staff, initiatives included the funding of an observatory for RI within the ICT theme (ORBIT, 2019), which includes web based resources and provides a range of training packages; the funding of several public engagement initiatives (e.g. in the area of quantum science) and the embedding of RI within its Impact and Translation Toolkit for Healthcare Technologies.

4.3.1. Calls and proposals analysis

To better understand the institutionalisation of RI across the EPSRC portfolio we first undertook an analysis of RI in calls for grant applications made by EPSRC between 2013 and 2017. Table 2 shows that in total 19% of all calls contained reference to RI, RRI or the 'AREA' framework over that period.

Explaining the rationale for this, one of our EPSRC respondents stated:

''where there have been topics of a sensitive nature, we have put it [RI] in … for the rest of the community it has been left as guidance [on the EPSRC website]''

The number of calls containing RI was observed to increase over the five-year period, rising from only a few call documents in 2013 and 2014 (i.e. the year after publication of the RI policy) to approximately one third of all call documents in the years 2015-2017.

Content analysis of these calls revealed that how RI was framed within the call documents varied considerably: from brief signposting to the RI framework, to (in a small number of cases) RI being an explicit requirement of funding. In 59% of calls that contained an RI element this was found to occur in the form of generic signposting to the AREA framework, with no further expectations of the applicants. This signposting emerged in 2015, as a result of text being added to the call boiler plate used by EPSRC staff, positioned as a brief paragraph of text at the end of the call documents. In 2016 and 2017 this was by far the most common approach taken in the calls. As one of our EPSRC respondents stated:

'it's only if a team has a real focus and understanding of RI for that specific call that they may go further…''

In 19% of those calls that made reference to RI applicants were asked to 'consider', 'consider and capture' or 'adhere' to the RI framework, but again in a non-specific way and with no further expectations of them. The exception to this was one call that was more assertive and detailed in its expectations, asking applicants to consider ''aspects of ethics… trust, identity, privacy and security [as well as] current public perceptions and attitudes' with a further assertion that 'EPSRC will not fund a project if it believes that there are ethical concerns that have been overlooked', although the mechanism by which EPSRC would ascertain this (e.g. via peer review) was not specified.

In 18% of those calls that made reference to RI applicants were asked not only to reflect on or consider the RI framework, but to additionally 'integrate' activities into their proposals. The 2013 Centres for Doctoral Training call (see below) and the Quantum Technology hubs were two large investments where there was this expectation of integration of RI – related, multi and trans- disciplinary activities. In only two calls over the period was an explicit link made between RI and the evaluation of proposals. One of our EPSRC interviewees provided a possible explanation for this observation:

'For EPSRC in terms of assessment criteria it is always research quality first…usually RI aspects are a subset of an assessment criteria… the calls where we are most likely to focus on RI are the bigger grants... and even in those ones RI may be a minor constituent of it [and] it's unlikely we would go to a social scientist [as part of peer review of applications] for such a small element'

Overall, there was a clear trend across the years: in 2013-2014 those calls that included RI were found to be more assertive, asking (or requiring) applicants to reflect on RI and integrate activities into their proposals. From 2015 to 2017, whilst RI featured in more calls, this often took the form of generic signposting with no further expectations of applicants.

Our analysis of all proposals submitted to EPSRC between April 2009 and February 2017 (Fig. 1) reveals there was a very low number of applications containing the keywords RI, RRI or the AREA framework between 2009 and 2013, prior to publication of the RI policy. This rose through 2013-2014, peaking in 2015-2016 and mirroring the rise in the overall number of call documents containing RI. In 2016-2017 there appears to have been a significant drop in the number of applications

Table 2
Funding call documents containing reference to RI *note data for 2017 represents partial year's results.

Year	No of publicly – available documents	No of Documents (% of total) containing references to RI, RRI or AREA framework
2013	74	4 (5%)
2014	79	7 (9%)
2015	78	24 (31%)
2016	56	19 (34%)
2017*	12	4 (33%)
Total	299	58 (19%)

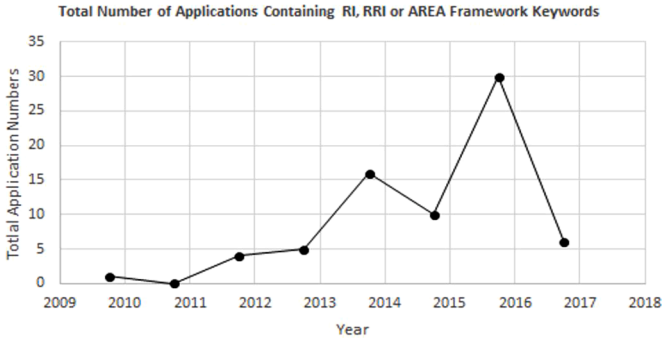

Fig. 1. Total number of applications received by EPSRC each year containing keywords RI, RRI or 'AREA' framework.

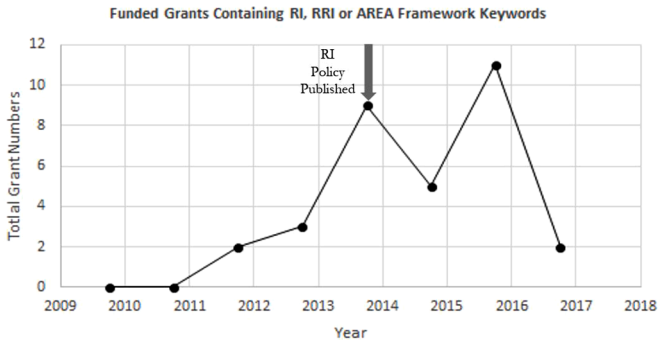

Fig. 2. Grants funded by the EPSRC 2009-2017 containing keywords RI, RRI or AREA framework.

containing RI. The data for 2016-2017 does not include a complete year, but since the keyword search was conducted in February 2017 it can be assumed that it captures most of the applications received before year end (March 2017). Overall, the number of proposals containing reference to RI remained very low as a proportion of the total number of applications received by the Council (0.8%, 2013-2014; 0.2%, 2014-2015; 1.2%, 2015-2016).

Fig. 2 shows that the number of funded proposals in the same period containing reference to RI mirrored the trend shown in Fig. 1. It should be noted that we were not able to ascertain from the data specifics concerning those RI activities being undertaken in these projects. Funded proposals were found to be concentrated in a small number of thematic areas. Almost half (47%) of the projects (in financial value) containing an RI element were found to be in the field of quantum technology. 25% of the projects (in value) containing RI were allocated to the Centres for Doctoral Training (see below) and a further 9% of funded projects were in the field of synthetic biology (e.g. within the Synthetic Biology Research Centres). In total, 81% of those funded projects (in value) containing an RI element were in these three thematic areas, with the remaining grants being in a small number of themes that included engineering grand challenges, healthcare technologies and the digital economy. The RI elements of those grants are likely to constitute a substantially smaller component of the grants in financial value and activity. Analysis of the call documents associated with these funded projects revealed that RI was specifically required, or applicants were expected to adhere to the RI framework, with the inclusion of a substantial paragraph of RI text in the call documents. Interestingly, the number of standard grant proposals (i.e. bottom-up, non – directed, 'responsive mode' proposals) containing an RI element was found to be extremely low, with only 8 proposals containing a reference to RI being received by the Council across the period 2009-2017 (i.e. an average of just 1 per year), of which only 2 grants were funded.

It seems reasonable to conclude that calls and proposals containing RI elements were restricted to a small number of themes where RI was strongly encouraged or required. Beyond these, i.e. in thematic areas where RI was not required and, in the standard, responsive mode portfolio, there appears to have been very limited response from the EPSRC – facing academic community.

4.3.2. PhD training programme analysis

In 2013/2014, EPSRC funded 115 Centres for Doctoral Training (CDTs) across a wide range of thematic areas (EPSRC, 2013b). Focussing on the training of PhD students, each CDT provides technical and transferrable skills training in addition to its core research element. Many lever additional studentships from other sources that include university, EU and industrial funding. The 2013 EPSRC funding call for proposals for CDTs was launched in the same year as the publication of its RI policy. Applicants were encouraged (but not mandated) to include RI elements into their training and EPSRC was not prescriptive as to what that training should involve. The Council did however suggest multidisciplinary approaches that facilitate reflection on broader societal and ethical implications of research, and to enable this suggested that CDTs consult and work with others from beyond the engineering and physical sciences, such as social scientists, ethicists and experts in public engagement. RI was not included in the funding assessment criteria.

Our analysis of the responses to the 2016 CDT midterm evaluation reveals that whilst 91% of the CDTs embedded some sort of ethics-related activities (with 60% reporting specific ethics training) and whilst some respondents described activities that they felt in a general way aimed to raise awareness of broader ethical, environmental, legal, political, cultural or social aspects of research, only 3.5% of the CDTs reported specific RI training in accordance with the AREA framework. A further 13% mentioned RI, but this was in a non-specific or only aspirational way e.g.:

''We have not yet implemented any formal Responsible Innovation training within the centre. However, we are planning to engage with the [X] reading and discussion group within the university to explore and develop concepts of RI''.

Our analysis suggests that by 2016 only a few institutions had embedded RI training within their CDTs.

Overall, our EPSRC calls and CDT analyses suggest an active phase of RI institutionalisation at the Council between 2009 and 2012. This led to the publication of a RI policy in 2013, and with this a statement of expectations for the Council and those it funds. The EPSRC's subsequent Delivery Plan (2016-2019), a key strategic document for the organisation, however made only one brief reference to RI and did not commit the organisation to any expected outcomes or ring-fenced resources. Our analysis suggests that the period between 2013 and 2017 was associated with further institutionalisation at the EPSRC and within research communities funded by it, with a rise in the number of proposals and grants funded containing an RI element. However, this was principally within a limited number of thematic areas and, even within these themes, institutionalisation appears to have been patchy, with for example only a small number of CDTs reporting specific RI training in accordance with the AREA framework. What seems clear is that the response from the EPSRC facing community as a whole over our period of analysis was low, with the total number of proposals received and funded by the EPSRC containing an RI element being below 1.5% of the total grant applications received or funded by the Council in any given year.

4.3.3. Interviews, workshop and focus groups analyses

To gain better understanding of the factors influencing the trends in our data described above we undertook an analysis of semi-structured interviews, workshops and focus groups with key stakeholders both within EPSRC and in its communities of practice in universities. This led to the identification of four overarching themes relating to RI institutionalisation, which are described in turn below. Illustrative quotes from our respondents are presented in Appendix 1.

4.3.3.1. Theme 1: external political drivers and incumbent organisational logics. Our respondents suggested RI institutionalisation faced significant challenges arising from a) the external, national political context and associated research and innovation policies and b) incumbent logics, norms and practices within universities. Concerning the former, respondents emphasised the dynamic and uncertain political environment in the UK. They also highlighted that whilst societal challenges provided a policy driver for research and innovation that intersects with RI, the overwhelming policy priority was to drive economic growth (national and regional) and to raise productivity through innovation, attached to significant sources of funding for UK universities e.g. the Government's Industrial Strategy (UK Government, 2017). Many interviewees suggested that RI institutionalisation is likely to encounter resistance if it is perceived to be at odds with (or is not instrumentally contributing to) this policy imperative.

Whilst a small number of (sometimes creative and innovative) RI

initiatives were noted by respondents, uptake across universities as a whole was felt to vary considerably. In one or two cases, RI was described as aligning well with the values and 'DNA' of a particular University (particularly those with a coherent civic mission) and even as a potential source of competitive advantage. However, in other instances RI both in concept and practice was observed to be encountering significant ambivalence, scepticism and, in some cases, outright resistance. Incumbent norms and established modes of producing knowledge within disciplines were described as posing significant challenges. This presented in different ways, including appeals to academic objectivity, freedom and autonomy, with RI at times being viewed as an additional burden and even as an unnecessary or unwelcome external interference. Connections were made between this ambivalence (or resistance) to RI and the way scientific education and training is undertaken from an undergraduate level onwards, where disciplinary norms and socialisation were described as being instilled from an early stage.

The value of and need for this additional (RI) activity were questioned, particularly by those who were generally persuaded by their own assumptions concerning the utility and social desirability of their research and by those who asserted that their research was some distance from future application, or not intentionally aimed at application or innovation at all. Some interviewees pointed to the current peer review system as being a significant barrier for RI, with its emphasis on scientific excellence from a highly technical but narrow perspective, and where claims (e.g. in the 'pathways to impact' sections of grant applications) made by applicants were not subject to any form of substantive, critical interrogation.

4.3.3.2. Theme 2: organisational expectations, incentives and resources. Our respondents pointed to organisational expectations of academics (codified in performance evaluations, reward and incentivisation schemes, career progression and recruitment criteria) as posing considerable challenges to RI institutionalisation. Respondents described a lack of organisational incentives for researchers across all disciplines to engage with RI, even suggesting that engaging could pose a risk (particularly for early career researchers) if it diverted time away from activities important for career progression and assessments of performance. Respondents noted the importance of periodic national research assessment regimes that privilege particular definitions of research quality and excellence (relating to originality, rigour, significance and impact) and which significantly influence and legitimate particular organisational practices and individual behaviours. These regimes they advocated would need to be reconsidered and changed.

Many of our respondents in universities highlighted a lack of resources, infrastructure, organisational capabilities and training for RI within their organisations and that RI was also not sufficiently coordinated at a national level. It was felt that the EPSRC had made available only limited resources specifically for RI activities, with the exception of some notable initiatives in key themes. Unlike the funding by the Research Councils of important public engagement initiatives in universities such as Beacons and Catalysts for Public Engagement in the past, RI it was felt lacked similar, dedicated resources. Under-resourcing of RI was also described by respondents within EPSRC itself.

4.3.3.3. Theme 3: RI domestication. Our respondents pointed to a lack of clarity and confusion as to what RI was perceived to mean and how it should be incorporated into daily practice. Where RI activities had been observed in universities, respondents suggested such activities as being at risk of suffering from an acute 'lack of imagination'. They noted a tendency to reduce, narrow, rationalise and domesticate RI within existing responsibility norms and practices, becoming synonymous with, amongst others, existing codes and norms of research integrity, ethics, risk assessment (e.g. laboratory health and safety) or outreach, science communication and ad hoc instances of public engagement. While respondents acknowledged that much could be learned from practices relating to, for example, public engagement, they voiced concerns about reducing RI to these and other de facto practices.

While some science and engineering curricula were noted as including such topics as engineering ethics and law, in the main a narrow approach to pedagogy was seen as contributing to academic socialisation, reductionism and the reification of norms within disciplines, all of which it was felt were hindering institutionalisation of RI within those disciplines. Some respondents suggested differences across disciplines and academic career levels, with early career researchers, and in particular PhD students, being an important constituency who they felt might be more willing and open to embracing RI and discussing the social, political and ethical dimensions of their research.

4.3.3.4. Theme 4: leadership and agency. Many of our respondents emphasised that effective RI institutionalisation was reliant on a small number of committed leaders, 'champions' and advocates who had agency and influence within organisations. They suggested that RI was a fragile discourse that could easily lose momentum if such individuals were lost to the organisation or were re-deployed. Respondents suggested that for RI to become established would require sustained effort and leadership over many years.

4.4. RI institutionalisation post 2017

Our interim assessment in early 2018, based on the data presented above, was that while there was evidence of some RI institutionalisation between 2013 and 2017 at EPSRC and the communities it funds, particularly in a small number of key themes, overall this had been limited in both scope and reach during the four years since publication of the RI policy. RI had very low visibility in the 2016-2019 Delivery Plan and the Special Interests Group, which had been instrumental in terms of initial institutionalisation and which had constituted a clear governance and communication channel within EPSRC, had since been disbanded. The guidance and policy for RI had effectively remained unchanged since 2013 and RI had not been integrated into the peer review process in a systematic or substantive manner. Our data pointed to a combination of external and internal factors that had fostered ambivalence and even resistance to RI institutionalisation in universities. The analysis was discussed with EPSRC between late 2017 and early 2018, with an internal report being submitted to the Council in April 2018.

The period post early 2018 appears to have signalled a new phase for RI institutionalisation, the outcomes of which are uncertain. In contrast to the previous corporate Delivery Plan (published in 2015), which had only one brief mention of RI, the Council's next iteration, published in 2019, was more assertive, with RI featuring comprehensively throughout the whole document, including the identification of concrete actions. Reflecting a desire to give RI a 'shot in the arm', in 2019 EPSRC commissioned a work stream in its Strategic Advisory Network to consider the strategic direction for RI, reporting to EPSRC Council in March 2020, and established a cross-office working group to develop understanding and raise awareness of RI across EPSRC.

In 2018 the EPSRC also launched a second call for CDTs (EPSRC, 2018). The approach to including RI in this call was markedly more assertive in comparison with the call made in 2013. RI featured prominently, with all PhD students now being required rather than encouraged to receive RI training in line with the AREA framework and with additional priority areas having a requirement for enhanced RI training. CDTs were required to demonstrate that resources had been committed to RI activities. In early 2019 EPSRC funded 75 CDTs. This programme promises to be a potentially significant location for a renewed phase of RI institutionalisation across UK universities receiving EPSRC CDT funding.

5. Discussion

The aims of our study were, first, to analyse the dynamics of

institutionalisation over a decade of one significant and influential discourse of responsible innovation (Stilgoe et al, 2013; EPSRC, 2013a). The context for our study is a research council and the research communities in universities funded by it. It goes without saying that further studies should consider RI institutionalism in other contexts e.g. in business, (Brand and Blok, 2019). Our second aim was to use this theoretically - informed analysis to develop recommendations for policy aimed at strengthening RI in organisational practice. We now discuss each of these aims in light of our findings.

In terms of the dynamics of RI institutionalisation, our literature review highlighted first the importance of legitimacy challenges to incumbent norms and practices as creating opportunities for new discourses such as RI to gain organisational purchase. It seems clear that previous science and technology controversies and crises - including the GM crisis, heuristically articulated through public concerns relating to synthetic biology (BBRSC, 2010) - as well as the 2011 SPICE climate engineering project (Macnaghten and Owen, 2011; Stilgoe et al, 2013) were important in raising legitimacy and performance challenges for EPSRC. These catalysed reflection on the sufficiency of current responsibility norms and practices, challenges to which EPSRC felt it needed to respond, particularly in emerging areas of techno-science that it funds such as nanoscience, geoengineering, ICT, quantum technologies and synthetic biology.

In addition to these 'shocks', we can point to other, more gradual forces for RI legitimation that manifested during our period of analysis (Streeck and Thelan, 2005; Smets et al, 2017). First, this period coincided with the adoption of more 'shaping' and 'sponsorship' type roles at the Council in addition to its funding administration remit (Nielsen et al., 2015). Second, it coincided with increasing emphasis on funding mode 2 type, strategic research and the rise of the 'impact' narrative within the UK research landscape (Hill, 2016), with the first national assessment of impact emanating from research in UK universities being conducted in 2014 (REF, 2014). Universities were now required to develop narratives of economic and social impact arising from their research tied to future research funding and grant applicants were now required to provide 'pathways to impact' statements in grant applications (Watermeyer, 2016). This created opportunities for a broader discussion concerning visions, motivations and impact pathways advocated by RI. Third, it coincided with an increasing emphasis on more deliberative and upstream forms of reflexive public engagement with science and technology (see Section 2.1). Finally, it is possible that the rise of the EC RRI agenda in Europe over the same period also played a legitimating role. We note however that our respondents rarely mentioned the EC RRI discourse, which we suggest emerged largely in parallel with the discourse of RI in the UK. Indeed, there is the possibility that the EC RRI discourse may have even introduced ambiguity and confusion given its somewhat narrow framing around the so called 'RRI keys'.

Our review also emphasised the importance of institutional entrepreneurship, which was evident within EPSRC throughout the period of analysis, for example through the actions of portfolio managers in key themes such as ICT. It was particularly noticeable during the earlier phases of RI institutionalisation by a small number of individuals at different levels of the organisation who had sufficient interest, agency and influence to support the building of an internal narrative around RI. But this was far from a strictly internal, bounded process. It also involved external actors, notably a small group of academics (including two of the authors) who undertook significant 'institutional work' (Lawrence and Suddaby, 2006; Lawrence et al, 2013) and who served as boundary spanners (Maguire et al, 2004). This was mediated through the EPSRC's Special Interests Group, which had an important governance role at the Council and a significant measure of influence and agency. These combined forces of legitimation, agency and entrepreneurship, involving aspects of theorisation (Greenwood et al, 2002), advocacy, resource mobilisation and coalition building, allowed RI to gain organisational traction, visibility and momentum. This culminated in the publication of the RI framework and policy in late 2013, at which point EPSRC itself became a significant source of legitimation for RI institutionalisation in those research communities it funds, principally in universities.

Our analyses suggest RI had a low profile within these research communities prior to 2013. It is important to note that there may well be practices in universities that potentially align with anticipatory, reflexive and deliberative approaches advocated by RI, but which may not be specifically labelled as such (Glerup et al., 2017; Schuijff and Dijkstra, 2020). In their recent review, Schuijff and Dijkstra (2020) note that where such approaches are observed, these tend to be aligned with just one of the RI dimensions described by Stilgoe et al (2013) rather than all four in an integrated manner. That said, we also note instances of experimentation around RI as an integrated approach, for example within some of the Synthetic Biology Research Centres and some Centres for Doctoral Training (Pansera et al., 2020; Reinsborough, 2020).

Notwithstanding these instances, overall our findings suggest RI institutionalisation since 2013 to have been partial and limited in both scope and reach. Our respondents further suggested that whilst RI remained important organisationally for EPSRC during this latter period, other priorities competed significantly with it for both time and financial resource. We suggest RI to have gained only limited social recognition to date, remaining largely within the bounds of localised innovation and theorisation (Greenwood et al, 2002, Fig 1). In offering an explanation, we situate RI institutionalisation within a higher education environment characterised by multiple, co-existing and competing logics (Streeck and Thelan, 2005; Ocasio et al 2017; Kraatz and Block, 2008; Shields and Watermeyer, 2018). These logics collectively serve as attention – drawing, 'stabilizing paradoxes' that create a multiplicity of constituent demands on contemporary UK universities (Hallet, 2010; Oliver, 1991). These logics pose considerable challenges for RI institutionalisation. This presented as appeals to the autonomy and independence of science, recourse to disciplinary norms, appeals to the contingency and unpredictability of research in relation to future uses, applications and impacts and, associated with this, de-limitation of role responsibilities (Douglas, 2003). It also surfaced in assumptions made by researchers regarding the social desirability of their research and its envisaged impacts, claims that RI may slow down or hinder innovation (Brand and Blok, 2019), claims that it is irrelevant for scientific practice (Glerup et al, 2017) or that it presents an additional and unnecessary bureaucratic burden.

Our findings draw particular attention to the prevailing external policy environment as a powerful counter-legitimating force for RI institutionalisation (Eizagirre et al., 2017), where an overwhelming political priority in the UK has been for publicly-funded research to instrumentally and unreflexively fuel innovation through a 'technology – market dyad' (Pfotenhauer and Juhl, 2017) aimed at economic growth, productivity and national prosperity (Docherty, 2016; Perkmann et al., 2013; Pfotenhauer et al., 2019; Taylor and Woods, 2020; UKRI, 2019).

Rather than diluting or displacing these incumbent logics and practices our findings suggest RI to be largely adding to these at a time when emerging policy is aiming to reduce additional bureaucracy for researchers (UKRI, 2020). This may be creating forms of 'responsibility-overload' as new responsibility imperatives are loaded onto universities by external pressures (here originating from EPSRC as a source of RI legitimation) whilst the original logics and corresponding obligations remain (Randles, 2017). Compounded by a lack of resources for RI and influential incentive and evaluation regimes, relating for example to academic performance assessments and career progression, RI as a supplementary practice presents potentially significant costs for academics increasingly subject to a 'hyperinflation of demands' (Gill, 2009). In this sense it can be argued that RI has inherited similar problems encountered by previous efforts in universities aimed at promoting transdisciplinary research and public engagement (Felt et al., 2016; Sykes and Macnaghten, 2013).

Our analysis points to a range of responses in turn at individual and organisational levels. In a small number of cases RI appears to have been embraced in a substantive way (Pansera et al, 2020). At the other end of

the spectrum there is evidence of outright resistance (Kuntz, 2017). Our findings also suggest buttressing by incumbents, for example through avoidance, defiance and manipulation (Oliver, 1991), partial conformity and responses that are tokenistic, ceremonial or symbolic in nature (Bercovitz and Feldman, 2008; Bromley and Powell, 2017). This includes forms of organisational decoupling such that RI does not substantively impinge on the organisation (Meyer and Rowan, 1977; Oliver, 1991; Boxenbaum and Jonsson, 2008; Kraatz and Block, 2008; Bromley and Powell, 2017), which is largely left to perform according to existing organisational logics. Bromley and Powell (2017) and Kern et al (2018) note that contexts of institutional complexity (such as universities) are particularly propitious for decoupling. Under such circumstances RI may become at most an occasional supplement (see Goos and Lindner (2015) for a further example of RI compartalisation in this respect). But it may also involve the repositioning of existing responsibility norms and practices as RI, or vice versa (Ashworth et al., 2019; Hartley et al., 2017; Taylor and Woods, 2020), limiting imagination and risking 'shallow' or superficial RI institutionalisation.

6. Conclusions

We believe this to be the first time that insights from organisational institutionalism have been applied to RI in an empirical study. Our analysis may lead to the conclusion that there has been limited RI policy impact to date and, in its harshest interpretation, even a failure of policy. An alternative interpretation is that our findings reflect the dynamics of an ongoing process of sense and meaning making, interpretation, theorisation and negotiation that is far from over, for a discourse that is being translated and transduced in manifold, situated ways (Doezsma et al., 2019; Hallet, 2010; Rip, 2014; Wedlin and Sahlin, 2017). This 'co-productionist' perspective (Jasanoff, 2004; Poftenhauer and Jasanoff, 2017; Pfotenhauer and Juhl, 2017) acknowledges that knowledge orders (here about the meaning of responsibility) and social orders (i.e. institutionalization and associated norms, policies and practices) are co-evolving and mutually shaping one other. In this interpretation, experimentation, contestation and responses such as de-coupling reflect the dynamics of translation of a performative discourse that is 'in the making' (Lindner et al., 2016; Rip, 2014; Smets et al., 2017; Wedlin and Sahlin, 2017).

We note that previous initiatives emerging from the UK Research Councils, for example concerning impact (Hill, 2016), have been decadal projects characterised by incentivisation, experimentation, resourcing, collective mobilisation, sustained leadership and persistent institutional work, including the introduction of formal expectations and sanctions. In light of this observation and our findings, we make several recommendations aimed at strengthening RI institutionalisation in publicly funded research environments such as universities. Our findings suggest EPSRC has focussed to date largely on advocacy, mobilising support and developing the skills and knowledge necessary for RI implementation. While these remain important, we also suggest the need for more assertive, regulative interventions i.e. governance in addition to funding and facilitation (Pfotenhauer and Juhl, 2017, p 79). Here we draw particular attention to the importance of research assessment and incentive regimes. Others have noted the potential for current configurations of these to limit the sorts of inter and trans disciplinary approaches advocated by RI (Hill, 2016; Martin, 2016). We recommend changes to periodic, national research assessment exercises to allow evaluation of the extent to which anticipatory, reflexive and deliberative practices have been integrated and incorporated into strategic research and, crucially, the impact this has had. Such formal mandates are important for addressing responses to initiatives that may be symbolic rather than substantive in nature (Bercovitz and Feldman, 2008). While research councils may not administer these national assessments per se they are a key intermediary between government and academia and constitute an important stakeholder with considerable influence.

Our second recommendation follows observations made by Bercovitz and Feldman (2008) concerning how academic researchers respond to the introduction of a new discourse such as RI. In their study of the introduction of technology transfer initiatives in universities they describe how responses reflect not only the values, imprinting and socialisation that academics have experienced as part of their academic formation and professional training but also the micro-organisational context in which they subsequently find themselves. They highlight the importance of local leadership and peer influences for influencing and modifying seemingly engrained behaviours. Our findings elsewhere (Pansera et al, 2020) show such micro-organisational influences to be important for RI institutionalisation, and to be particularly effective when combined with an approach that opens up creative, collaborative spaces for reflection, anticipation and engagement (Reinsborough, 2020; Timmermans et al., 2020). Recognising this, we recommend investment by research councils in future leadership programmes and the further embedding of RI in doctoral programmes in ways that are substantive, meaningful, creative, adequately resourced and supported by supervisors. Early indications from the recently funded EPSRC Centres for Doctoral Training suggest considerable potential for RI institutionalisation in this regard.

We close with brief observations prompted by our study regarding the development of theory. If RI is a discourse at least in part inspired by STS, our study suggests opportunities for further cross pollination and theoretical development at the interface of STS and organisational institutionalism. This could open up the potential to provide further insights concerning the ongoing translation of RI as a policy relevant discourse. This might include empirical exploration of organisational decoupling (Bromley and Powell, 2017), recoupling (Hallett, 2010) and how this might be influenced by relationships of mutual dependency, accountability and power, such as may exist between research funders, universities and disciplines within these (Kern et al, 2018). It also offers potential to provide insights for case studies of institutionalisation of other policy-relevant cognates (Forsberg, 2014) of which the EC discourse of RRI (Novitzky et al., 2020) is just one.

CRediT authorship contribution statement

Richard Owen: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Mario Pansera:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing - original draft, Writing - review & editing, Visualization, Project administration. **Phil Macnaghten:** Conceptualization, Validation, Writing - review & editing. **Sally Randles:** Conceptualization, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper

Acknowledgements

This research was funded by the Economic and Social Research Council (Grant no. ES-077-26-0001) and the European Union's Horizon 2020 Research and Innovation Programme, (Grant no. 709637. We thank staff at the EPSRC for access. We also thank comments made by two anonymous reviewers which greatly strengthened our manuscript.

Appendix 1

Table 3
Themes emerging from interviews with illustrative quotes [note this table could be placed in Supplementary Material].

Theme	Illustrative Quotes from Respondents
Theme 1:External political context Incumbent organisational norms Theme 2: Organisational expectations, incentives and resources Theme 3: RI domestication Theme 4: Leadership and agency	"[the Industrial Strategy] is all about how to create a post-Brexit economy, it's not creating a better world. That is why it's there… we identify the challenges that would prevent future economic growth. There is no argument about that and there is no embarrassment. It's not the only investment, the problem [for RI] is it's the only one that people are talking about now." "ultimately the final direction [for science and innovation] is to contribute to UK prosperity''''We embedded [RI] in the curricula, we reflect when we were wrong…this is seen as an advantage…the ideas around RI and ethics in research is a selling point'' ''We discovered quite a bit of political resistance within the University. There were some people, researchers, staff who seemed to benefit from the status quo and were quite reluctant to take this change on.'' "We discussed this in the University at a very high level. There were questions about the responsibility of the University itself. There was a sense that RI at an institutional level, institutional reflexivity, is not particularly desirable, which was interesting in itself." "There is still this notion of RI as a sort of an invasion…. It's a political invasion…. Of course science has never been neutral I think, so it's a bit misleading to think about it in this way but I still think though it's this mentality..." "Physics is successful because it only deals in facts of nature, not in "societal concerns" ''it's threatening for them … and this is linked to some of the fundamental ideas on science they have… It's threatening their perception of scientific autonomy'' "I am coming to the conclusion that there's something that happens very early in scientists training. …. They [are] locked into their way of thinking very early on…' "They think [innovation] is good or inevitable. So, they actually don't engage in their mind [to critically consider] if what they do is actually socially desirable. They write arguments and proposals about why [their research] is a social good, but it is only to get funding." ''..when you are doing [research] day in day out and it's your area of expertise you make assumptions and you think this is the obvious next step and that's fine and that's because you're comfortable with it and you may have been working on it for years….'' 'researchers think what they are doing is a social good…[they] make claims about what the public want… their visions'… [group think]…'they make claims to a peer group that has the same views as them' 'for researchers building a career, [RI] is not a high priority, competing with other activities which will enhance their career prospects. They will need to develop a portfolio of things which are well regarded in academia''… "taking part in RI activities is not rewarded'' '' I think that RI should become part of what it means to do high quality excellent research. It seems to be a separate thing, but it should be part of the whole'' ''I'd like to see [RI] become a normal part of the pathways to impact and a normal part of grants'' '' I hope that by 2031 RI will be in the [UK Research Excellence Framework] and excellent research will overlap with RI'' "[researchers] want to engage with [RI] but because there is no infrastructure there to support engaging with it…they have nowhere to go with it." ''There's been quite a lot of people around the office who have been involved with it [RI] and touched it at various stages…everyone in the office knows about it but not everyone has experience of it and understanding of it but that is because of workload and resourcing issues...there are just a lot of [other] priorities at the minute'' "Some [EPSRC] researchers were very aligned with the principles of RI…. But overwhelmingly what we found was a lack of imagination about what RI could be. Even when researchers were aligned with the values of RI and wanted through science to change things for good, wanted to align their research to societal needs, they wanted to engage, they just couldn't imagine who to engage and how to do it. Lack of imagination I think was potentially one of the biggest barriers." 'For a lot of people a lot of the time they might know something about it, the headings and the words but they may think of it as a tick box exercise: we'll do it according to these principles without really living it…we'll get a social scientist involved to take care of it…'' ''everything gets conflated with talking to the public'' "For them [it] was clear [RI] was about research integrity. And for many of them it was just about public engagement for ticking boxes'' "...there is a lot of confidence about public engagement... but as regards anticipation, reflexivity and responsiveness we couldn't find any.' "Most scientific researchers…. I don't think that they have particular training in ethics of technology... I imagine that's missing from a lot of scientific training, certainly not all of it but much of it." "[what we need is] a sort of careful balance between cultivating independent scientists with a real love of science in the pure sense, but also cultivating scientists as citizens'' "It varies, I tend to see that the younger people are much more open, the doctoral students, some of the senior people also… but the senior [ones]…. I wouldn't know the percentage, but there's definitely the feeling this is a threat." "I think where we have had the most success [with RI] is dealing with Post Docs, dealing with Doctoral students and dealing with undergraduate students who are happy and excited to engage" ''One of the real lessons here is leadership is everything, without it you have nothing… it [RI] literally fell apart as soon as the [senior leader and RI advocate] went… the institutionalization of [RI] disappeared… there was nothing'' "..where there is now the strongest presence of RI in the councils I think at the moment is in the EPSRC ICT portfolio….and I think that was very much because {individual} as the head of the portfolio is behind it…supports it…thinks it is a good idea…wants to push it. If {individual} were replaced tomorrow, then we would face a very strong uphill battle" "And then {individual} left and here we are…everything stopped. The new guy came in and we're all in a limbo''. ''It can be quite hard to get the whole community to appreciate RI in fundamental physics or mathematics and it takes a long, sustained effort to get the community to start appreciating it''

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